

***SD Department of Environment & Natural Resources
Watershed Protection Program
Total Maximum Daily Load***

***Redfield Lake Watershed Spink County, South Dakota
March 1999***

These TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the US Environmental Protection Agency. The 1998 303(d) Waterbody List identified Redfield Lake as impaired by a measure of accumulated sediment and Trophic State Index (TSI) which serves as an indicator of the trophic condition of the lake. TMDLs for accumulated sediment and total phosphorus have been developed and are supported below.

TMDL Summary for Accumulated Sediment

Waterbody Name	Redfield Lake
Hydrological Unit Code (HUC)	10160009
TMDL Pollutant	Accumulated Sediment
Water Quality Target	Remove 250,000 cubic yards of sediment
TMDL Goal	Increase depth by 5 feet over 31 surface acres (250,000 cubic yards)
303(d) Status	1998 303(d) Waterbody List, Priority 1, Pages 22, 29, 33
Targeted Beneficial Uses	Warmwater marginal fish life propagation, immersion recreation, limited contact recreation
Reference Document	Lake Assessment Project Report Lake Redfield (SDDENR, 1993)

TMDL Summary for Total Phosphorus

Waterbody Name	Redfield Lake
Hydrological Unit Code (HUC)	10160009
TMDL Pollutant	Total Phosphorus
Water Quality Target	In-lake phosphorus TSI of 90
TMDL Goal	45% reduction in total phosphorus inflow
303(d) Status	1998 303(d) Waterbody List, Priority 1, Pages 22, 29, 33
Targeted Beneficial Uses	Warmwater marginal fish life propagation, immersion recreation, limited contact recreation
Reference Document	Lake Assessment Project Report Lake Redfield (SDDENR, 1993)

I. Executive Summary:

• Waterbody Description and Impairments

Redfield Lake is a reservoir on Turtle Creek located just outside of the town of Redfield in the southwest corner of Spink County in east central South Dakota. The lake was formed in the mid- 1930's by damming lower Turtle Creek in southwest Spink County. The overflow from Redfield Lake enters into the James River about 6 miles downstream. The watershed above the dam encompasses an area of 1,414 square miles (905,000 acres) distributed over five counties in east central South Dakota. Surface area of the lake at normal level (at spillway crest) is approximately 170 acres that can increase to 1900 acres at flood pool (at the dam crest). Average depth in 1993 was about 7.0 feet with a maximum depth of 12.0 feet. The dam has an outlet control structure so the pool can be drawn down if needed. A sediment depth survey conducted in 1986 estimated 275,000 cubic yards of loose sediments have accumulated in Redfield Lake in the last 50 years.

This watershed contains three other impoundments that are also on the 1998 303(d) Waterbody List. These lakes and watershed areas are listed below:

Cottonwood Lake	151,500 acres
Lake Louise	104,700 acres
Jones Lake	23,400 acres

Redfield Lake provides flood protection for downstream areas of Turtle Creek as well as recreational opportunities (fishing, swimming, boating, etc.) for local users. The surface water quality standards for Redfield Lake established the lake's beneficial uses as warmwater marginal fish life propagation, immersion recreation, limited contact recreation, and wildlife propagation/stock watering.

The data for the Lake Assessment Project was collected in 1991 and the final report came out in May of 1993. The assessment project report indicated the lake was heavily overgrown with cattails. The report also indicated that the lake is receiving excessive amounts of phosphorus most notably in the form of dissolved phosphorus (78%). Sediment and nitrogen loads to the lake do not appear to be excessive. Samples taken in 1989, 1991, 1992 and 1994 had nitrogen to phosphorus ratios (N:P) that varied yearly between 2:1 and 4:1. Based on the large concentrations of in-lake phosphorus and the relatively smaller concentrations of nitrogen, the lake can be classified as nitrogen limited lake.

• Stakeholder Description

City of Redfield	NRCS
Spink County	James River Water Development District
Spink Conservation District	South Dakota Conservation Commission

- *Intent to Submit as a Clean Water Act Section 303(d) TMDL*

In accordance with Section 303(d) of the Clean Water Act, the South Dakota Department of Environment and Natural Resources submits for EPA, Region VIII review and approval, the total phosphorus and accumulated sediment total maximum daily loads (TMDLs) for Redfield Lake as provided in this summary and attached document. These TMDLs have been established at a level necessary to meet the applicable water quality standards for nutrients and sediment with consideration of seasonal variation and a margin of safety. The following designated use classifications will be protected through implementation of this TMDL: warmwater marginal fish life propagation, immersion recreation and limited contact recreation.

II. Problem Characterization:

- *Maps*

See Figure 1.

- *Waters Covered by TMDL*

Redfield Lake is the waterbody targeted by this TMDL.

- *Rationale for Geographic Coverage*

The 905,000 acre Redfield Lake watershed consists of approximately 53% native grassland, 24% non-native grasses and 23% cropland. The estimated population within a 65-mile radius of Lake Redfield is 62,644 and 10,152 people reside within a 30-mile radius of the lake. Lake use was determined by a 1990 SD GF&P survey at 3000 man-days per year. The number of boats on the lake in 1990 averaged two per day.

- *Pollutant(s) of Concern*

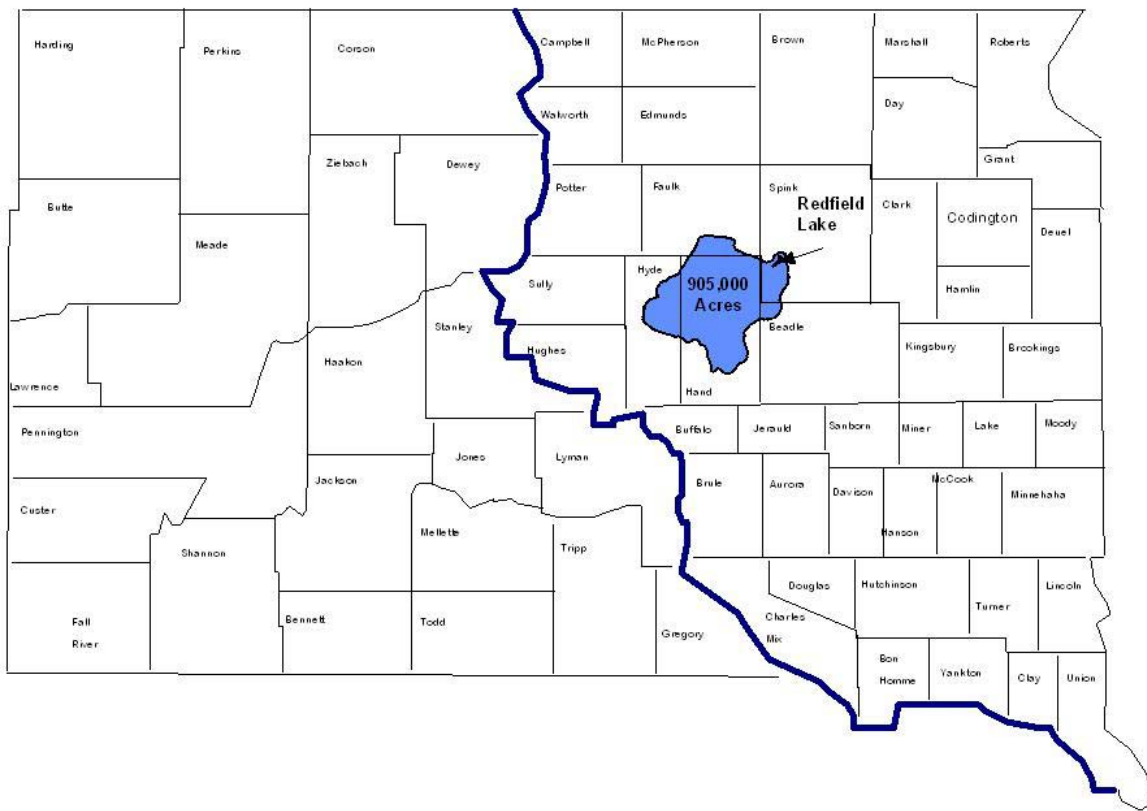
Total phosphorus

Accumulated sediment.

- *Use Impairments or Threats*

The beneficial uses for Redfield Lake established by the State of South Dakota surface water quality standards are warmwater marginal fish life propagation, immersion recreation, limited contact recreation, and wildlife propagation/stock watering.

Figure 1. Redfield Lake and 905,000 acre watershed



The sediment load that is accumulating in Redfield Lake appears to be quite large, but it is actually small when considering the enormous size of the watershed. The sediment that has accumulated in the lake has caused the lake to lose some of its depth. In areas of the lake that were shallow (especially near shore) it has silted in enough to provide ideal conditions for cattail growth. The assessment report estimated that 80% of the shoreline is overgrown with cattails. This limits the public access to the shoreline and in general reduces the recreational potential of the lake.

Excessive phosphorus loads to Redfield Lake have resulted in impairments to the beneficial uses of immersion recreation, limited contact recreation and warm water semipermanent fish life propagation. The phosphorus load to Redfield Lake has resulted in excessive nuisance vegetation growth (cattails) and increased eutrophication. The result of this eutrophication, is a loss of aesthetics of the lake, occasional odor problems, seasonal low dissolved oxygen concentrations and increased threat of winterkill and as a result impairs designated beneficial uses of the lake.

- *Probable Sources*

The results of the 1993 Lake Assessment Project Report showed that the in-lake mean total phosphorus concentration was 0.68 mg/L of which 81% was dissolved phosphorus. The mean tributary phosphorus concentration was 0.90 mg/L of which 78% was dissolved phosphorus. These high percentages of dissolved phosphorus may be indicative of water contamination from animal and/or human wastes and runoff from over fertilized cropland. The 1993 report stated that runoff from livestock operations in the watershed was the suspected primary source since yields of dissolved phosphorus (and nitrogen) in feedlot runoff are often much larger than those of other non-point sources in rural areas.

Due to the large watershed area to lake surface area ratio (5323:1) for Redfield Lake, large amounts of sediment are transported into the lake through the Turtle Creek inlet. Redfield Lake does not appear to be trapping a large amount of this sediment. The load out of the lake appears to be only slightly less than the load into the lake. On average, approximately 0.24 inches of sediment per year is deposited in the lake. This number is based on the 1986 sediment survey that estimated 275,000 cubic yards of sediment had been deposited in the lake over the prior 50 years.

The 1993 assessment report estimated for 1991, that 3700 cubic yards of sediment entered the lake while only 3343 cubic yards left the lake. This is equivalent to 0.02 inches on the entire lake bottom for the year of 1991. The 1993 study showed that the total suspended solids (TSS) delivered to the lake did not appear to be high and were probably near or below the average for prairie streams on a per acre of watershed comparison. This indicates that sheet and rill erosion is not a significant source of sediment for this watershed.

The study also includes a shoreline survey and the results show that heavy erosion may be occurring on 5% of the shoreline and moderate erosion may be occurring on 6% of the shoreline. The study indicated that shoreline erosion may be contributing significant sediment loads to the lake.

III. *TMDL Endpoint:*

- ***Description***

The TMDL goal for Redfield Lake is to reduce the in-lake annual mean total phosphorus concentration by 45%. Reducing inflow concentrations of phosphorus will result in a lower ambient total phosphorus concentration in Redfield Lake. A lower phosphorus concentration in the lake will result in a smaller standing crop of blue-green algae at any given time and will result in algal "blooms" of a lower intensity and shorter duration over time. This will improve average dissolved oxygen concentrations in the lake and therefore be beneficial to the fish life propagation.

The accumulated sediment TMDL goal for Redfield Lake is to remove 270,000 cubic yards of sediment from the lake. This will increase the depth of the lake by five feet over 31 surface area acres. Removal of sediment will increase the depth and clarity of the lake, which will then improve the lake as a fish life propagation and increase the recreational uses.

- *Endpoint Link to Surface Water Quality Standards*

- Total phosphorus*

The TMDL target is to reduce total phosphorus TSI to <90. The current mean total phosphorus TSI is 98, according to data collected as part of the Statewide Lakes Assessment.

- Accumulated sediment*

The TMDL goal is to increase the depth of the lake by five feet over 31 surface acres.

IV. *TMDL Analysis and Development*

- *Data Sources*

Data used for the Redfield Lake TMDL was taken from the 1993 Lake Assessment Project Report for Redfield Lake, lake sedimentation data collected by DENR in 1986 and the 1995 Lake Assessment Report. These documents are located in the Water Resources Assistance Program office of the SD DENR.

- *Analyses Techniques or Models*

Hydrologic and water quality monitoring data was obtained from the three main tributaries to Redfield Lake and from two in-lake sampling sites as well as from the outlet of the lake. This data was used in the lake loading calculations as well as the TSI calculations and reductions. Additional in-lake water quality data was taken from the 1995 South Dakota Lakes Assessment Final Report produced by the SD DENR.

Samples collected at each site were taken according to South Dakota's EPA approved Standard Operating Procedures for Field Samplers. Water samples were sent to the State Health Laboratory in Pierre for analysis. Quality Assurance/Quality Control samples were collected on 10% of the samples according to South Dakota's EPA approved Clean Lakes Quality Assurance/Quality Control Plan.

- *Seasonality*

In-lake samples were collected for the 1993 study from January 1991 through September 1992. The tributary samples were collected from April 1991 through November 1991. To determine seasonal differences, Redfield Lake in-lake samples were separated into spring (March-May), summer (June-August), fall

(September-November) and winter (December-February) collection periods. The tributary samples were separated into spring (April-May), summer (June-August), fall (September-November). There were no winter samples collected on the tributaries due to unsafe ice conditions.

This study period was characterized by unusually mild winters and cool summers. The average rainfall for the watershed is about 18 per year and over the two years of the study the average rainfall was about 22 inches per year.

- *Margin of safety*

The margin of safety for the Redfield Lake accumulated sediment TMDL will be the removal of an additional 20,000 cubic yards of sediment from the lake over the water quality target of 250,000 cubic yards. In addition 3 feet of sediment will be removed over an area of 24 acres to prevent additional cattail growth. This will result in additional 112,000 cubic yards of sediment removed from the lake.

The current Section 319 implementation project is expected to result in a 25% reduction in in-lake total phosphorus concentrations over time. This together with the 29% reduction, which was achieved by landowners from 1991 to 1994, will result in a 54% reduction in inlake phosphorus overall. This represents a 9% margin of safety over the 45% reduction goal.

V. Allocation of TMDL Loads or Responsibilities:

- *Wasteload Allocation*

There are no point sources of pollutants of concern in this watershed. Therefore, the "wasteload allocation" component of these TMDLs is considered a zero value. The TMDLs are considered wholly included in the "load allocation" component.

- *Load Allocation*

The primary source of phosphorus appears to be from runoff from rangeland, with a high percentage of native grasses. Animal feeding areas are also important sources of phosphorus to Redfield Lake. The tributary loading data showed 81% of the phosphorus entering the lake was dissolved phosphorus. Additional phosphorus loading can be attributed to runoff from cropland in the watershed.

Removal of 270,000 cubic yards of soft sediment from Redfield Lake will reduce suspended solids and the particulate fraction of total phosphorus. Stabilization of 1000 linear feet of eroding lakeshore will also reduce suspended solids and associated total phosphorus.

- *Allocation of Responsibility*

At the beginning of the assessment period, the average annual total phosphorus concentration was measured as 0.68 mg/L. Due to improved grazing practices and better conservation by watershed agricultural producers, the average annual total phosphorus concentration was measured as 0.487 mg/L by 1994. This resulted in a 29% reduction for average annual in-lake total phosphorus concentration from 1991 to 1994.

Based on the 1993 lake assessment report and the 1995 Section 319 project implementation workplan, actions, needed and already completed, to reduce phosphorus from rangeland and animal feeding areas include the following:

- 16, 071 feet of fence have been installed for grazing management systems.
- Installed four dugouts and cleaned out another two dugouts.
- Installed one cattle crossing.
- Installed two new wells for livestock watering and helped seven producers pipe water to pastures.
- Installed two animal waste systems and moved 2 feedlots.

These actions are expected to result in a 25% reduction in in-lake total phosphorus concentrations over time. This together with the 29% reduction, which was achieved by producers from 1991 to 1994, will result in reaching the goal of a 45% total in-lake phosphorus reduction plus a 9% margin of safety.

The South Dakota Lakes & Streams Association has already removed 195,000 cubic yards of sediment in partnership with the City of Redfield and Spink County Conservation District. They are scheduled to remove an additional 75,000 cubic yards in the summer of 1999. A private landowner cooperated with other project stakeholders to fence off a half-mile of lakeshore to prevent livestock from watering in the lake.

VI. *Schedule of Implementation:*

Implementation of practices commenced on this watershed during June of 1996 and will be completed in the fall of 1999. A sediment removal operation started on Redfield Lake in 1997. Approximately 195,000 cubic yards of phosphorus rich sediment was removed from the lake through the fall of 1998. In addition, 75,000 cubic yards of sediment is scheduled for removal in the summer of 1999. Approximately 1000 feet of severely eroding shoreline was repaired and stabilized. These two actions will result in a smaller internal load of phosphorus and increased clarity of the lake due to a reduction in suspended sediment.

In the summer of 1999, a half-mile section of Redfield Lake's shoreline is scheduled to be fenced to keep cattle from watering in the lake. A 100 foot buffer

strip will be managed between the pasture and the lake. In addition about 19,179 rods of trees have been planted in the watershed to reduce erosion.

Actions already taken to reduce phosphorus from rangeland and animal feeding areas include the following:

- 16,071 feet of fence have been installed for grazing management systems.
- Installed four dugouts and cleaned out another two dugouts.
- Installed one cattle crossing.
- Installed two new wells for livestock watering and helped seven producers pipe water to there pastures.
- Installed two animal waste systems and moved 2 feedlots.

VII. Post-Implementation Monitoring:

The Redfield Lake 319 implementation project will finish in the fall of 1999. In order to determine if the TMDL is being satisfied, more data is required. A post-implementation watershed or lake assessment may be conducted sometime after two to four years to determine if Redfield Lake is meeting all of its beneficial uses. It is believed that the improvements of the implementation activities have not had enough time to fully manifest in improvements in water quality. Redfield Lake will be included in the South Dakota Statewide Lake Assessment and will be sampled every two to four years.

VIII. Public Participation:

• Summary of Public Review

The water quality assessment was initiated after requests from the Spink County Conservation District and the City of Redfield were made to SD DENR. The Spink County Conservation District was the sponsor of the project. Public meetings were held throughout the assessment period, as well as during the project implementation.

EPA Section 319 grant funds (\$289,711), consolidated grant funds (\$283,000), James River Water Development District (\$20,000), City of Redfield (\$158,040), Spink Conservation District (\$40, 195, \$19,550 inkind), NRCS (\$107,695 inkind), cooperated in providing the necessary funds to complete this project (Project Implementation Proposal). In addition, individual farmers in the Redfield Lake/Turtle Creek watershed provided matching funds (\$128,633 inkind).

• Project Information and Education Efforts

The following table summarizes the efforts taken to gain public education, review and comment during TMDL development:

<i>Public Meetings/Personal Contact</i>	<i>Articles/Fact Sheets</i>	<i>Document Distribution</i>
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Pre-project meeting Funding meeting Mid-project meeting Near-end project meeting Final project meeting		Spink Conservation District Spink County City of Redfield NRCS
<i>Electronic Media</i>	<i>Mailings</i>	<i>Public Comments Received</i>
March, 1999 TMDL Summary advertised on department website	Interested parties March 10, 1999 Stakeholders March 10, 1999 Daily Newspapers March 8, 1999	Comments received during project meetings and review of the draft report and findings were considered.

IX. Supporting Development Documents (attached):

South Dakota Department of Environment and Natural Resources, Pierre, South Dakota. Lake Assessment Project Report, Lake Redfield, Spink County, South Dakota. May 1993.